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LUMINARY MEMO # 252

To: Distribution
From: D. Eyles
Date: 20 November 1972
Subject: EMP to Convert a Bad HMEAS

This memo presents an EMP whose job is to divide HMEAS, containing the landing radar altitude measurement, by a factor of 5 in between the measurement and its use to update the LM state vector. The problem thus confronted would arise from the failure of one of two suspect transistors in the landing radar unit to be flown on Apollo 17. The result of this failure is that radar altitude data does not arrive until about 12000 feet altitude and that, when it does arrive, until the low-scale discrete appears, it is 5 times too big.

The EMP is executed 50 times a second as part of the downrupt. It is prepared, activated, and terminated in the now familiar ways. It is restart protected. The EMP continually examines the RNGEDBIT of FLGWRD11. When this bit is set, indicating that an altitude reading has been stored in HMEAS at STORALT, and when a signal word is zero indicating that the divide has not been done yet on this HMEAS, then the signal word is set positive and the contents of HMEAS are multiplied by .2 and replaced. There is at least a fifth of a second between the loading HMEAS and its use in the update routine. When RNGEDBIT is reset, after the incorporation of HMEAS, the signal word is zeroed again so that the next HMEAS will be corrected.

Operationally, the EMP should be loaded before PDI (because it is too big to be keyed in later), and activated with V 31 E once the problem has declared itself, which happens at 40000 feet or so. Since the data in HMEAS becomes correct once the low-scale point is reached around 500 feet, the EMP must be disabled before this point. The easiest way to do this is to anticipate the low-scale point and do a V 58 E, disabling the landing radar, just before it is reached. Assuming good data since 12000 feet, a manual landing without radar data should be easy from this point. (Ther was not enough room in the vac area to include coding to make the EMP disable itself upon receipt of the

low-scale discrete.)

This EMP has been tested sucessfully on the all-digital simulator at MIT.

The EMP itself follows on the next page:

EMP to use if HMEAS is too big by 5...

```
660   00000   reserves VAC5
661   10752   CCS     PHASE1
662   00670   TC      670
663   05355   TC      PHASCHNG
664   07011   OCT     07011
665   77777   OCT     77777
666   00676   ADRES   676
667   10100   OCT     10100
670   30107   CA      FLGWRD11
671   74741   MASK    RNGEDBIT
672   10000   CCS     A
673   00710   TC      710
674   54727   TS      signal
675   03532   TC      DNPHASE2
676   34746   CA      ZERO
677   54660   TS      VAC5USE
700   30703   CA      address
701   54335   TS      DNTMGOTO
702   05263   TC      TASKOVER
703   00661   address of EMP

710   10727   CCS     signal
711   03532   TC      DNPHASE2
712   24727   INCR    signal
713   35007   CA      EBANK7
714   54003   TS      EBANK
715   31655   CA      HMEAS +1
716   00006   EXTEND
717   70730   MP      factor
720   54001   TS      L
721   34746   CA      ZERO
722   53655   DXCH    HMEAS
723   00006   EXTEND
724   70730   MP      factor
725   21655   DAS     HMEAS
726   03532   TC      DNPHASE2

727   00001   signal (initially non-zero)
730   06315   factor (about .2)
```

Procedures:

To prepare:

Load EMP.
Key V 5 N 26 E 00001 E
00676 E
10100 E.

To activate:

Key V 31 E.

Description:

The EMP is processed 50 times a second in the downrupt. Using RNGEDBIT and its own signal word the EMP detects when HMEAS has just been stored by the read routine for use by the update routine. Before the update coding grabs it (a window of more than .2 second) the EMP multiplies HMEAS by .2 and puts it back.